AD-A049 265 FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OHIO F/G 20/2
THE STATISTICAL THEORY OF THE SCALE FACTOR,(U)
JUL 77 T A KONTOROVA

UNCLASSIFIED FTD-ID(RS)T-1263-77 NL

| OF |

AD
A049265

END
DATE
FILMED
3-78
DDC

AD-A049265

FTD-ID(RS)T-1263-77

FOREIGN TECHNOLOGY DIVISION

(1)

THE STATISTICAL THEORY OF THE SCALE FACTOR

by

T. A. Kontorova

FTD- ID(RS)T-1263-77

UNEDITED MACHINE TRANSLATION

FTD-ID(RS)T-1263-77 29 July 1977

MICROFICHE NR: FTD-77-C-001049

THE STATISTICAL THEORY OF THE SCALE FACTOR

By: T. A. Kontorova

English pages: 19

Source: Sbornik Dokladov po Dinamicheskoy Prochnosti Detaley Mashin, Izd-vo Akademii Nauk SSSR, Moscow-Leningrad, 1946, pp 178-184

Country of origin: USSR
This document is a machine translation
Requester: AFFDL/FBRD
Approved for public release; distribution unlimited

PREPARED BY:

TRANSLATION DIVISION
FOREIGN TECHNOLOGY DIVISION
WP-AFB, OHIO.

U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ё in Russian, transliterate as yё or ё. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

GREEK ALPHABET

Alpha	Α	α		Nu	Ν	ν	
Beta	Β	β		Xi	Ξ	ξ	
Gamma	Γ	γ		Omicron	Ο	ο	
Delta	Δ	δ		Pi	Π	π	
Epsilon	Ε	ε	ϵ	Rho	Ρ	ρ	ϱ
Zeta	Ζ	ζ		Sigma	Σ	σ	ς
Eta	Η	η		Tau	Τ	τ	
Theta	Θ	θ	ϑ	Upsilon	Υ	υ	
Iota	Ι	ι		Phi	Φ	φ	ϕ
Kappa	Κ	ϰ	κ	Chi	Χ	χ	
Lambda	Λ	λ		Psi	Ψ	ψ	
Mu	Μ	μ		Omega	Ω	ω	

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English
sin	sin
cos	cos
tg	tan
ctg	cot
sec	sec
cosec	csc
sh	sinh
ch	cosh
th	tanh
cth	coth
sch	sech
csch	csch
arc sin	$\sin^{-1}$
arc cos	$\cos^{-1}$
arc tg	$\tan^{-1}$
arc ctg	$\cot^{-1}$
arc sec	$\sec^{-1}$
arc cosec	$\csc^{-1}$
arc sh	$\sinh^{-1}$
arc ch	$\cosh^{-1}$
arc th	$\tanh^{-1}$
arc cth	$\coth^{-1}$
arc sch	sech^{-1}
arc csch	csch^{-1}

---

rot	curl
lg	log

GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

Page 178.

THE STATISTICAL THECRY CF THE SCALE FACTOR.

T. A. Kontorova.

Introduction.

At these experimental conditions the so-called ductile-to-brittle transiticn temperature, i.e., the temperature, which corresponds to the transition of crystal material from brittle state to plastic, is determined first of all by the value of its brittle strength.

Recall that, according to Joffe's circuit, the ductile-to-brittle transition temperature is the abscissa of the point of intersection of the curve, which characterizes the temperature dependence of yield point, with the straight line whose position on this same diagram is determined by the numerical value of the brittle strength of crystal. From this circuit it follows that, independent of experimental conditions, each this material always must answer one and the same value of ductile-to-brittle transition

temperature T_c

More detailed experimental research on the conditions of the emergence of the brittle state of real crystals showed, however, that the position of ductile-to-brittle transition temperature significantly depends on the rate of the strain of specimen/samples.

By a series of the researchers establish/installed that an increase in the rate will entail increase T_c. Simultaneously it turned out that the material can be transferred into "brittle" state also at constant temperature of experiment because of an increase in the rate to certain critical value v_c. The numerical ratio between velocity v_c and the temperature of experiment T was for the first time establish/installed by Vitman [1], that showed that during dynamic testing steel specimen/samples is justified well the law

$$v_c = ae^{-\frac{b}{T}}, \qquad (1)$$

where a and b - constant.

We have examined the theoretical side of the question concerning the reasons for the effect of the rate on the tendency of crystals toward brittle fracture [2]. In this case it was established that the critical speed of deformation v_c, corresponding to the transition of material to brittle state, must be bonded with the temperature of

experiment T by the relationship/ratio

$$v_c = \frac{F}{\eta} = \frac{F}{\eta_0} e^{-U/kT}, \quad (2)$$

where F - brittle strength, $\eta = \eta_0 e^{\frac{U}{kT}}$ - the ficticious coefficient of the ductility/toughness/viscosity of material, U - the activation energy, determining the rate of the process of relaxation in crystal lattice.

Page 179.

This relationship/ratio is in good accord with empirical formula (1). We will use it for the determination of the analytical dependence of ductile-to-brittle transition temperature T_c from the value of brittle strength F.

Taking the logarithm of (2), at this constant value of the velocity of deformation v we obtain

$$T_c = \frac{A}{\lg F + B}, \quad (3)$$

where A and B - constant, whereupon $A = \frac{U}{k}$, $B = \lg(v\eta_0)$. From formula (3) it follows that decrease in the strength of material F must lead to an increase in its ductile-to-brittle transition temperature, i.e., at the beginning of brittle fracture in the range of higher temperatures.

Experimental research on the conditions of the transition of crystal bodies from brittle state to plastic showed, however, that this transition never occurs at the strictly defined value of temperature, but it is realize/accomplished in certain temperature interval, named the transformation range of brittleness. The detailed study of this interval was for the first time carried out by Davidenkov, Vitman and Sakharov [3] and somewhat later by Vitman and Salitra [4], that studied the conditions of the cold brittleness of steel specimen/samples.

The existence of the transformation range of brittleness naturally was in this case bonded from themes by the fact that the brittle strength, determining the position of ductile-to-brittle transition temperature, is not a constant value, but it is changed from one specimen/sample to the next as a result of heterogeneous structure of real crystal material.

In recent years in Davidenkov's laboratory in the L.I.P.T. was conducted systematic research on the character of the effect of different factors on the transformation range of the brittleness of steel.

In the first part of the present report were presented the results of the experiments of Vitman [5], which showed that the position of the boundary/interfaces of this interval is subjected to the effect of the so-called "scale" factor, whereupon the width of a very interval of brittleness was different for the specimen/samples cf different size/dimension.

Investigating the form of fracture of the cylindrical steel specimen/samples of different diameter during deformation by their percussive elongation, Vitman reveal/detected that an increase in the diameter of specimen/samples is accompanied by the shift both of lower and upper boundary of an interval of brittleness to the side of higher temperatures. In this case an increase of the diameter of specimen/samples from 2 tc 10 mm leads to an increase in lower boundary of an interval of T_{min} by 60° (from -160 to -100°), whereas upper boundary T_{max} is misaligned altogether only to 15° (from -100 to -85°C). As a result of this nonuniform shift of boundary/interfaces the width of the transformation range of brittleness is decreased from 60 to 15°.

With an increase in the size/dimensions of specimen/samples their tendency toward brittle fracture it begins, thus, to be developed with ever more and higher temperatures, but the temperature range, in which can be observed both brittle and plastic form of

fracture, becomes narrow.

The target/purpose of the present report/communication is theoretical studies of the reasons for a similar character of the effect of scale factor on the behavior of the transformation range of brittleness in light of the developed by us previously statistical theory of the brittle strength of real crystals [6. 7].

Page 180.

QUALITATIVE SOLUTION TO QUESTION.

At the basis of this theory lie/rests the assumption about the fact that in real crystal material are flaw/defects of the different hazard level, randomly distributed by its volume, and that for the brittle fracture of each of the specimen/samples heavy-duty/critical is only one, most dangerous of all being present in it flaw/defects.

Already some these purely good-quality representations it proves to be sufficiently in order to understand the reasons for the effect of scale factor on the transformation range of brittleness and to confirm that with an increase in the size/dimensions of the specimen/samples:

1) both boundary/interfaces of this interval must be misaligned to the side of high temperatures,

2) the shift of lower boundary of an interval T_{min} must be sharper, rather than the shift of upper boundary T_{max} as a result of which the transformation range of brittleness will be narrowed.

If the spread of the values of critical temperatures, i.e., the very existence of the transformation range of brittleness, is caused by the presence of the scatter of the practical values of brittle strength F within limits from certain F_{min} to certain F_{max} then, according to (3), the position of upper boundary of an interval T_{max} will be determined by the relationship/ratio

$$T_{max} = \frac{A}{\lg F_{min} + B}, \qquad (4)$$

the position of lower boundary T_{min} - by the analogous relationship/ratio

$$T_{min} = \frac{A}{\lg F_{max} + B}. \qquad (5)$$

On the basis of the representation of that which for the brittle fracture of material heavy-duty/critical is only the most dangerous of all available in this specimen/sample flaws, it is possible to

confirm that an increase in the volume cf specimen/samples must involve a fall in the numerical values both F_{min} and F_{max} since with an increase in the size/dimensions of specimen/samples grow/rises probability that in each of them will be met the flaw/defects, even more dangerous, rather than it is earlier.

Fall F_{min} and F_{max} and, correspondingly, shift T_{max} and T_{min} to the side cf high temperatures [see (4) and (5)] probably however, not identical, since values themselves F_{min} and F_{max} are determined by completely different conditions. Actually, it is the brittle strength of that of all subjected to testing specimen/samples of the given size/dimension, in which accidentally located most dangerous of all being present in these specimen/samples flaw/defects.

Fall F_{min} can therefore occur only in that case if as a result of an increase in the volume of specimen/samples in them appear the flaw/defects completely new, of the worse "quality", i.e., only in such a case, when is expanded the very "assortment" of the flaws, which are contained in the total the volume of material being investigated.

If number of experiments, conducted during the determination of the brittle strength of material, in each individual case is sufficiently great, then this expansion of the "assortment" of flaws

one should relate to events little protable.

Page 181.

The bonded with it shift of lower boundary of an interval of the possible values of brittle strength F_{min} and, consequently, also the upper limit of the transformation range of brittleness T_{max} must not be therefore considerable.

As concerns F_{max} this value it is brittle strength the strongest made of all subjected to testing specimen/samples, i.e., the strength of that specimen/sample, in which most dangerous of all being present in it flaws turned out to be less "dangerous", rather than the most dangerous flaws in each of all remaining specimen/samples.

Shift F_{max} to the side cf the low value of F is bonded therefore not with the expansion of the common/general/tctal assortment cf flaw/defects in all specimen/samples, together taken, but only with the expansion of the batch of flaws in each of the specimen/samples individually.

The latter unavoidably must, however, accompany an increase in the volume of specimens, even under the conditicn of the invariability of the batch of flaws in an entire mass of material.

Scale factor must therefore have a considerably more noticeable effect on shift F_{max} and, correspondingly, T_{min} rather than for shift F_{min} and T_{max}.

These good-quality considerations wonderfully are confirmed by experimental data of Vitman.

The statistical theory of brittle strength.

If for the brittle fracture of crystal bears responsibility "dangerous itself" of all being present in it flaw/defects, then from the point of view of determining the brittle strength of material there is practical interest in only the question concerning are such the parameters, which characterize this most dangerous flaw/defect.

As the parameter, which characterizes the degree of the danger of each of the being present in material unhomogeneity, we will select the value of brittle strength F, which would possess the specimen/sample if the source of its fracture they was this unhomogeneity.

With the aid of the very elementary considerations of theory of probability it is possible to show that probability W (F) dF that that the brittle strength, which corresponds to the most dangerous flaw/defect, i.e., the strength of specimen/sample as a whole, will turn out to be that which lie at an interval between F and F + dF, will be determined by the function

$$W(F)\,dF=\overline{N}VCe^{-\alpha(F_0-F)^2}\left[1-\frac{e^{-\alpha(F_0-F)^2}}{2\sqrt{\pi\alpha}(F_0-F)}\right]^{\overline{N}V}dF, \qquad (6)$$

where F_0 - the value of brittle strength, which corresponds to the most frequently being encountered flaw/defect, i.e., to the flaw/defect of the "average/mean hazard level", $\overline{N}$ - the average number of flaw/defects, which is necessary per unit volume of material, V - the volume of specimen/sample, α and C - constant.

Relationship/ratio (6) testifies from that that probability W (F) dF meeting of one value or the other of the strength of specimen/sample, determined upon consideration of all numerous material defects, depends not only on the value of strength itself F, but also on the volume of specimen/sample of V.

It is easy to show, further that the most probable strength F* the group of the specimen/samples of volume of V, i.e., the strength,

which is determined by the condition

$$\frac{\partial W}{\partial F}=0,$$

also is function of V. With an increase in the volume of specimen/samples of V it diminishs according tc the law

$$F^*=F_0-\sqrt{C_1\lg V+C_2}. \qquad (7)$$

Page 182.

EFFECT OF SCALE FACTOR ON THE SCATTER OF THE PRACTICAL VALUES OF BRITTLE STRENGTH.

At this constant value V dependence of probability W (F) dF meeting of certain determined brittle strength F on value itself F will be depicted as the asymmetric curve, given in Fig. 1. On the axis of abscissas is noted the position of the most probable strength F*, and also strengths F_0, the corresponding to flaw/defect "average/mean danger".

After manufacturing the infinite number of experiments regarding the brittle strength of the specimen/samples of certain specific size/dimension, we would be obtained, after all, all points of the

theoretical curve of Fig. 1. In actuality, we always have, however, matter with the finite number of experiments and practical interest for us it represents only the range of the most frequently being encountered values of strength F, i.e., the range of values F, of close to F*. The approximate position of upper and lower boundaries of this range F_{max} and F_{min} is shown in Fig. 1. Difference $F_{max}-F_{min}=\Delta F$ is the effective width of the maximum of the distribution curve of the possible values of brittle strength.

The curve, given in Fig. 1, illustrates the behavior of function W (F) dF for the specimen/samples of intended sizes. During a change in the volume of specimen/samples the range of the procedurally important values of strength F is misaligned. The relative attitude of the curves of W (F) dF, which correspond to two different values of volume V_1 and V_2, where $V_2 > V_1$, it is represented in Fig. 2.

Increase in V will entail the shift of the most probable strength F* to the side small F [see formula (7)] during a simultaneous increase in the probability of meeting F = F*. The latter means that an increase in the volume of specimen/samples leads to decrease in the scatter of the values of brittle strength near the most probable strength F*.

With respect is changed the position of upper and lower

boundaries of this range F_{max} and F_{min}. Schematically the shift F_{max} and F_{min}, caused by a change in the volume of specimen/samples of V, it is noted in Fig. 2 under the plotted function W (F) dF.

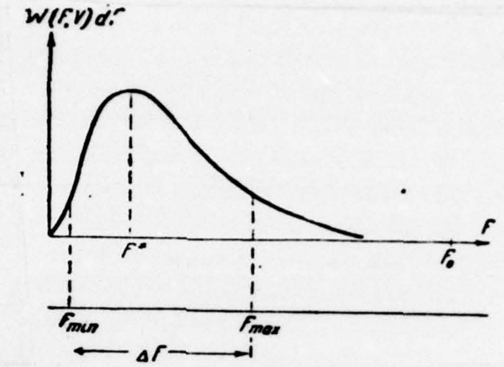

Fig. 1.

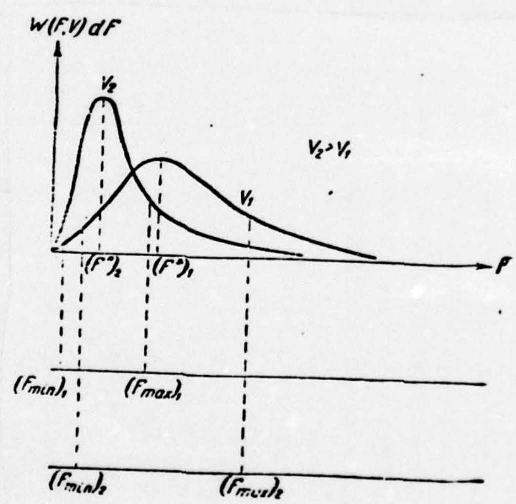

Fig. 2.

Page 183.

From the figure follows that decrease in the scatter of the procedurally important values of brittle strength is explained by the preferred displacement/movement of upper boundary F_{max} the range of the maximum of the distribution curve of the possible values of F in question.

The analytical dependence F_{max} and F_{min} on the volume of specimen/samples of V can be found on the basis of the following simple considerations.

If we define F_{max} and F_{min} as upper and, correspondingly, lower the boundary of the region, in which are included the most frequently being encountered in practice values of brittle strength F, then this means that the probability of the meeting of values F, exceeding F_{max} but it is equal also values F less F_{min} is small.

We will assume in connection with this:

$$\int_{F_{max}}^{F_0} W(F)\,dF=\gamma, \quad \int_{0}^{F_{min}} W(F)\,dF=\gamma, \tag{8}$$

where $\gamma \ll 1$.

These relationship/ratios will give us possibility to

establish/install interesting us quantitative communication/connection between F_{min} and F_{max} and value of V.

After using formula (6), which determines function W(F)dF, after approximative integration we obtain

$$\left(1-\frac{e^{-\alpha F_0^2}}{2\sqrt{\pi\alpha}F_0}\right)^{\bar{N}V}-\left[1-\frac{e^{-\alpha(F_0-F_{min})^2}}{2\sqrt{\pi\alpha}F_0}\right]^{\bar{N}V}=\gamma,$$
$$\left[1-\frac{e^{-\alpha(F_0-F_{max})^2}}{2\sqrt{\pi\alpha}F_0}\right]^{\bar{N}V}=\gamma. \quad (9)$$

Solving equations (9) relatively F_{min} and F_{max} we find

$$F_{min}\approx\frac{1}{2\alpha F_0}\lg\left(1+\frac{\gamma a}{V}\right),$$
$$F_{max}\approx\frac{1}{2\alpha F_0}\lg\frac{a}{V}, \quad (10)$$

where

$$a=\frac{2\sqrt{\pi\alpha}F_0e^{\alpha F_0^2}}{\bar{N}}.$$

Of relationship/ratios (10) in accordance with the developed above good-quality considerations it follows that an increase in the volume of specimen/samples of V will entail fall both F_{min} and F_{max}.

These relationship/ratios testify also about the fact that

change in V differently affects position F_{min} and F_{max} causing the relatively sharper shift of upper boundary F_{max} investigated by us the range of the practical values of brittle strength.

The effective width of the maximum of the distribution curve of the possible values of brittle strength ΔF will be determined by the expression:

$$\Delta F = F_{max} - F_{min} = \frac{1}{2\alpha F_0} \lg \frac{a}{V + v_0}. \qquad (11)$$

From (11) it is obvious that an increase in the size/dimensions of specimen/samples is accompanied by decrease in the scatter of the practical values of brittle strength F near its most probable value F*.

Page 184.

5.

THE INFLUENCE OF THE SCALE FACTOR ON THE CRITICAL RANGE OF BRITTLENESS

After using establish/installed by us ratios (4) and (5) between the boundary/interfaces of the transformation range of brittleness T_{max} and T_{min} on one hand, and by the boundaries of the region of the most

frequently being encountered values of brittle strength F_{min} and F_{max} - with another, we we can now find the numerical ratios, which determine the dependence of the position of the boundary/interfaces of the transformation range of brittleness frcm the size/dimensions cf specimen/samples.

Substituting in (5) found by us above apprcximate value F_{max} and, correspondingly, in (4) value F_{min} we ottain

$$T_{min} = \frac{A}{\lg \lg \frac{a}{V} + b},$$
$$T_{max} = \frac{A}{\lg \lg \left(1 + \frac{\gamma a}{V}\right) + b}, \qquad (12)$$

where constant a it is determined by formula (10), but constants A and b make following sense [see (2) and (3)]:

$$A = \frac{U}{k}, \quad b = -\lg (2\alpha F_0 V \tau_0). \qquad (13)$$

The width of the transformation range of brittleness ΔT is equal to respectively

$$\Delta T = T_{max} - T_{min} = A \left[\frac{1}{\lg \lg \left(1 + \frac{\gamma a}{V}\right) + b} - \frac{1}{\lg \lg \frac{a}{V} + b} \right]. \qquad (14)$$

From relationship/ratics (12) it follows that an increase in the volume of specimen/samples of V must be accompanied by shift T_{max} and T_{min} to the side of high temperatures. A change in the size/dimensions of specimen/samples ("scale factor") will in this case have a preferred effect on the position of lower boundary of the transformation range of brittleness T_{min} (recall that the factor γ, entering the determination T_{max} is much less than the unit). The transformation range of brittleness (14) with an increase in the size/dimensions of specimen/samples will as a result become narrow.

All these conclusions are in full/total/complete accord with the given in the first part of the report experimental data on the tendency of steel specimen/samples toward brittle fracture, which testifies as it seems to us, in favor of the developed above representations of the statistical nature of "scale" effect.

BIBLIOGRAPHY.

1. Ф. Ф. Витман. ЖТФ 9, 1070, 1939.
2. Т. А. Конторова. ЖТФ 9, 1086, 1939.
3. Ф. Ф. Витман, Н. Н. Давиденков и Г. С. Сахаров. ЖТФ 5, 418, 1935.
4. Ф. Ф. Витман и Я. Салитра. ЖТФ 8, 1356, 1938.
5. Ф. Ф. Витман Влияние масштабного фактора (см. в этом сборнике).
6. Т. А. Конторова. ЖТФ 10, 886, 1940.
7. Т. А. Конторова, Я. И. Френкель. ЖТФ 11, 173, 1941.

END MT/ST-77-1263.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FTD-ID(RS)T-1263-77	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) THE STATISTICAL THEORY OF THE SCALE FACTOR		5. TYPE OF REPORT & PERIOD COVERED Translation
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) T. A. Kontorova		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Foreign Technology Division Air Force Systems Command U. S. Air Force		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE 1946
		13. NUMBER OF PAGES 19
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

ACCESSION for		
NTIS	White Section	X
DDC	Buff Section	☐
UNANNOUNCED		☐
JUSTIFICATION		
BY		
DISTRIBUTION/AVAILABILITY CODES		
Dist.	AVAIL. and/or SPECIAL	
A		

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

20

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DISTRIBUTION LIST

DISTRIBUTION DIRECT TO RECIPIENT

ORGANIZATION	MICROFICHE
A205 DMATC	1
A210 DMAAC	2
B344 DIA/RDS-3C	8
C043 USAMIIA	1
C509 BALLISTIC RES LABS	1
C510 AIR MOBILITY R&D LAB/FIO	1
C513 PICATINNY ARSENAL	1
C535 AVIATION SYS COMD	1
C557 USAIIC	1
C591 FSTC	5
C619 MIA REDSTONE	1
D008 NISC	1
H300 USAICE (USAREUR)	1
P005 ERDA	1
P055 CIA/CRS/ADD/SD	1
NAVORDSTA (50L)	1
NASA/KSI	1
AFIT/LD	1

ORGANIZATION	MICROFICHE
E053 AF/INAKA	1
E017 AF/RDXTR-W	1
E404 AEDC	1
E408 AFWL	1
E410 ADTC	1
E413 ESD	2
FTD	
CCN	1
ETID	3
NIA/PHS	1
NICD	5